Testing the Degree of Market Integration and Price Transmission in Major Onion Markets of Pakistan

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ABSTRACT

The present study seeks to explore degree of market integration and price transmission in major onion markets of Pakistan using Co-integration technique and Error Correction Mechanism (ECM). Average monthly wholesale prices (January 2000-December 2009) of four onion markets Lahore, Hyderabad, Peshawar, and Quetta were used for analysis. The findings of the study revealed that selected four major onion markets were integrated with each other. The results of Error Correction Mechanism for pair of onion markets showed that 5 to 28.5 percent of the disequilibrium was removed each time period i.e. one month. This implies that following one standard error shock to the selected markets which cause disequilibrium, economic agents take 3 to 4 months to adjust the disequilibrium and move back to long run equilibrium. These findings were supported with the results of Granger causality analysis which confirmed the presence of co-integrating relationship among the variables. The high degree of market integration observed in this case is consistent with the view that onion markets in Pakistan are linked with each other for price transmission and related physical arbitrage.

Keywords: *Error Correction Mechanism, onion markets, physical arbitrage, price transmission and Granger causality*

Studi ini berusaha untuk mencari tingkat integrasi pasar dan transmisi pasar untuk mayoritas pasar bawang merah di Pakistan dengan menggunakan teknik Co-Integration dan Error Correction Mechanism (ECM). Analisis menggunakan penjualan rata-rata per bulan pasar bawang merah di Lahore, Hyderabad, Peshawar, dan Qeutta (Januari 2000-Desember 2009). Hasil dari penelitian ini adalah adanya integrasi satu dengan yang lain dari keempat pasar bawang merah. Hasil dari ECM menunjukkan angka 5 sampai 28.5 penghilangan disekuilibrium setiap bulannya untuk satu pasang pasar bawang merah. Menurut standar one error shock, hal ini mengindikasikan bahwa agen ekonomi mempunyai 3 sampai 4 bulan

untuk menyesuaikan pada disekuilibrium dan kembali pada ekuilibrium. Hasil tersebut didukung oleh temuan kasualitas Granger yang memberi konfirmasi terjadinya integrasi satu sama lain diantara variabel-variabel. Tingkatan integrasi yang tinggi untuk pasar bawang merah di Pakistan konsisten dengan keterhubungan pasar dalam hal transmisi harga dan arbitrase fisik.

Kata-Kata Kunci: *Error Correction Mechanism, pasar bawang merah, arbitrase fisik, transmisi harga dan kausalitas Granger*

INTRODUCTION

It has been noted that with the passage of time, the vegetables are getting more and more important regarding their production, marketing and consumption. Vegetables have dietary importance and also contribute to high income for the farmers. If we investigate dieting importance of vegetables, it becomes clear that these are highly beneficial for the maintenance of health and prevention of diseases. These consist of vital food ingredients which can be efficiently utilized to build up and repair the body. Vegetables help in preserving alkaline reserve of the body. They are rich in carbohydrate, vitamins and mineral contents. The vegetables may be edible roots, stems, and leaves traits or seeds. The above mentioned groups contribute to diet in different ways (GOP 2011).

The growth of vegetables production and consumption is because of its prime importance in daily life. As it adds value to food related to nutrition. This addition in value of food may be in the form of vitamins, minerals and amino acids needed by the body and hence they are considered as productive supplementary food; vegetables provide us minerals like calcium, phosphorus and iron. The mineral content of vegetables varies with the fertility of the soil. It is observed that minerals present in soil are absorbed by the vegetables.

As mentioned earlier that Pakistan has suitable climate for almost every kind of crop. As far as the vegetables are concerned, Pakistan is well diversified as number of vegetables is grown there. More than 36 species of vegetables are grown and consumed as summer or winter vegetables. Among these potatoes, onions, chilies, tomato and cucurbit are major vegetables. These vegetables are grown in different regions of the country. It means that certain locations are suitable for the production of specific kind of vegetables for example; districts of Okara, Sahiwal, Sialkot, and Kasuar are famous for production of onion.

Vegetables are important in two respects i.e. dietary importance and economic importance. Dietary importance has been explained earlier, as far as economic importance is concerned, these help in reducing the poverty because of the of the fact that these are generally cultivated on small pieces of land and farmers having small land holdings can grow vegetables and in this way they earn livelihood for themselves and for their families. Moreover as the cultivation of vegetables is labor intensive so in rural areas it can be used to provide employment to people who are unskilled and unemployed.

Certain regions in country are suitable in production of various vegetables from where these are transported to other parts of the country to meet the needs of population. 80-85% of vegetables production in Pakistan is marketable surplus of which 25-35 percent are wasted due to post harvest losses. These losses are caused by different factors which

include harvesting at inappropriate time, improper packaging and inadequate infrastructure for storage and transportation (Lohano and Mari 2005).

Because of climatic conditions and soil fertility a variety of vegetables are grown in Pakistan. Among them onion occupies special place because of their production, marketing and consumption. This vegetable is the important part of daily house hold activities related to food and are considered part and parcel of kitchen. Because of this important factor this vegetable is consumed throughout the year in all provinces of Pakistan. As mentioned earlier this vegetable has certain production areas from where these are transported in other regions of the country.

The area under cultivation of onion in Punjab is increased up 55.40% from 2000-2001 to 2009-2010, while that of Sindh the area is decreased by 18.33% in 2009-2010 as compared with 2000-01. In case of Balochistan the area shows increasing trend as clearly seen from table. It increases by 70.64% in 2009-2010 as compared with 2000-2001 while that of KPK area under cultivation of onion is also increased up to 15.09% in 2009-2010 as compared with 2000-2001. As far as provisional share in area under onion cultivation was concerned Sindh province dominated by contributing 33.92% of total area followed by Punjab, Baluchistan and KPK contributed 28.78%, 27.50% and 9.78% respectively (GOP 2010).

One of the most important goals of the agricultural policy is to make clearer the price signals of agriculture markets within the individual markets and the markets outside. On a spatially integrated market, price information should freely flow among all the markets. National Government and their regulations should help to acquire the goal of common integrated and efficient market. For a small open economy, market efficiency and price information flow has important political consequences.

In Pakistan in past research activities much emphasis is given studies related to area and production of onion, while relatively little is known about how price transmission is important to correct market imperfections, guide and regulate production, consumption and marketing decisions overtime. Such information is important for vegetable growers (onion) and other chain role players as well. In context of this study, market performance will be investigated by studying how successfully the price signals transmitted from one market to another market. Is there any casual relationship present between the markets? What is the direction of causality?

LITERATURE REVIEW

Tahir and Riaz (1997) studied the integration of agricultural commodity markets in southern Punjab, Pakistan. They used weekly prices of wheat, cotton and rice from 1993 to 1995 for this purpose. The results of their study for each commodity showed that all cotton markets were not integrated in the short-run all cotton markets because of the repetition of data used in the study and the integration was consisted of two different steps in the processing process (cotton lint and seed cotton). The cotton markets were also not integrated in the long-run except Bahawalnager. The rice markets of Chistian and Bahawalnager were integrated with the Multan market in the short-run. However, the Haisilpur and the Pakpattan markets were isolate. Some rice markets were not integrated in the long-run. The same case was with all selected wheat markets only Hasilpur market was not integrated with the Multan market in the long-run. None of the wheat market was integrated in the short-run. Moreover they told that markets

were integrated only in the long-run, while in some cases few markets were also integrated in short run.

Moreover small markets were more likely to be separated as compare to the larger markets. The small markets also take more time to completely adjust to the price fluctuations producing from a more dominant important market. Lohano and Mari (2005) analyzed the phenomena of market integration of onion in four regional markets of Pakistan. They adopted error correlation model (ECM) to observe the level of relationship regarding prices in four selected markets. They used monthly whole sale real price data in four selected markets namely Hyderabad, Lahore, Peshawar and Quetta cities. Their study showed that trading markets are spatially linked because of strong spatial price signals were transformed among these markets. Dad (2007) studied the extent of market integration in apple markets in Pakistan. He observed wholesale monthly price data of apple from 1996 to 2005 in selected apple markets. He used the time series technique (Co-integration and error correction models) in the framework of law of one price to find market integration among important apple markets. He concluded that prices in different markets were linked together to represent that the apple markets were integrated with each other and were lying in same economic market. Zahid et al. (2007) studied long run market integration for wheat between central market (Lahore) and five feeder markets (Faisalabad, Sargodha, Gujranwala, Gujrat and Sialkot). The Engle and Granger test of co-integration was used to find long-run market integration between the central market and five feeder markets. The results from the analysis clarified that market couples of Lahore-Gujranwala and Lahore-Faisalabad were completely linked with each other in long-run. The reason behind those integrated markets was improved infrastructure, resemblance of social attributes and effective communication between those markets. The pairs of Lahore-Gujarat, Lahore-Sargodha, and Lahore-Sialkot markets were not fully integrated. The rationale behind these partially integrated markets was large distance among markets, social and cultural differences and in effective flow of information among the markets. Those market pairs did not have any direct road and rail link for transportation of commodities were not mutually integrated. They suggested that Government should improve basic infrastructure among major markets, especially roads and rails and should be constructed to improve the flow of information. Ghafoor et al. (2009) used monthly wholesale price data (Rs. /100 kg) among major mango markets in Pakistan for the period 1990-2006. At two levels, market integration was tested i.e. overall and between pairs of mango markets by taking Karachi as a base market. They concluded that integration was present among major mango markets of Pakistan. Markets took time of almost 1 to2 to adjust for disequilibrium in one month while it would remove any disequilibrium during the period of 2-6 months and to bounce back to long run equilibrium. Mari (2009) studied about the production and marketing phenomenon of potato, onion and chilies. He concluded that yield of vegetables in Sindh have grown at higher rate when compared to other provinces. Moreover he concluded that Punjab province is increasing its onion production to fulfill the demand of its population and to reduce dependency on Sindh and Baluchistan. He suggested that Ministry of Food, Agriculture and Livestock Government of Pakistan should intervene in giving guidelines to enhance production of onion and optimum land use in Pakistan regarding cultivation of vegetables. Moreover he investigated that the vegetables are mainly produced by small and medium farmers and these crops are labor intensive so their cultivation and production is a source of income distribution in different classes of rural population. The results revealed that high competition was present between retailers and wholesalers and their profit margins were not so large. The results further revealed that the market of onion, tomato and chilies across different parts in Pakistan were working efficiently and the price signals were transformed from one market to the

other. The results further revealed that markets were integrated and there were spatial price linkages across regional markets. Hussain (2010) in his study they used the monthly wholesale price (Rs. /40 kg) data from January 1991 to December 2006 of gram, he find the market integration by using Logarithmic form and empirically estimated the degree of integration in gram markets of Pakistan using co- integration analysis. Co-integration results showed that all gram markets were Co-integrated in the Long run. The high degree of market integration observed in this case was consistent with the view that Pakistan's gram markets were quite competitive and provided little justification for extensive and costly government intervention designed to improve competitiveness to enhance market efficiency.

MATERIALS AND METHODS

The concept of cointegration (Granger 1981) and the methods for estimating a cointegrated relation or system (Engle and Granger 1987; Johansen 1988, 1991, 1995) provide a framework for estimating and testing for long run equilibrium relationships between non stationary integrated variables. Time series data is often non-stationary which if regressed as such provide spurious results, which may be misleading. So the first step in dealing time series data is to test for the presence of unit root in the individual time series of each model. Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981), both with and without a deterministic trend was used for this purpose. The number of lags in the ADF-equation is chosen to ensure that serial correlation is absent using the Breusch-Godfrey statistic (Greene 2000, 541). The ADF equation is required to estimate the following by OLS.

$$\Delta P_t = \alpha_3 + \beta_3 t + (\phi_3 - 1) P_{t-1} + \sum \theta_t \Delta P_{t-1} + \mu_t \ldots\ldots\ldots \quad (1)$$

Where P_t is the series under investigation and μ_t is the error term. If two series are integrated of the same order, Johansen's (1988) procedure can then be used to test for the long run relationship between them. The approach adopted in this paper is based Sims (1980) methodology of a general unrestricted vector autoregressive (VAR) model where unlike single equation methods, exogeneity of one price is not imposed *ex ante*; long run market integration is examined using Johansen's cointegration procedure.

$$\mathbf{X_t} = \delta + \mathbf{A_1 X_{t-1}} + \mathbf{A_2 X_{t-2}} + \ldots + \mathbf{A_{p-1} X_{t-p+1}} + \varepsilon_t \ldots\ldots\ldots (2)$$

Where X_t is a (n x 1) vector of endogenous variables, δ is a (n x 1) vector of parameters, Ai are (n x n) matrices of parameters and ε_t is a (n x 1) vector of random variables. In this model price series for the ten major mango markets were the endogenous variables and as such no exogenous variable was taken. To test the hypothesis of integration and cointegration in the equation (2) we transform it into its vector error correction form.

$$\Delta \mathbf{X_t} = \mu + \mathbf{\Gamma_1 \Delta X_{t-1}} + \mathbf{\Gamma_2 \Delta X_{t-2}} + \ldots + \mathbf{\Gamma_{k-1} \Delta X_{t-k+1}} + \boldsymbol{\pi} \mathbf{X_{t-k}} + \varepsilon_t \ldots\ldots\ldots (3)$$

Where $\mathbf{x_t} = [P_{1t}, P_{2t}]'$, vector of endogenous variables, which are I(1), $\Delta \mathbf{x_t} = \mathbf{x_t} - \mathbf{x_{t-1}}$, μ is a (2×1) vector of parameters, $\mathbf{\Gamma_1}, \ldots, \mathbf{\Gamma_{k+1}}$ and $\boldsymbol{\pi}$ are (2×2) matrices of parameters, and ε_t is a (2×1) vector of white noise errors. Where $\boldsymbol{\pi}$ is of reduced rank, that is r≤1, it can be

$$\begin{bmatrix} \Delta P_{1t} \\ \Delta P_{2t} \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \Gamma_{i,11} & \Gamma_{i,12} \\ \Gamma_{i,21} & \Gamma_{i,22} \end{bmatrix} \begin{bmatrix} \Delta P_{1t-i} \\ \Delta P_{2t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} \begin{bmatrix} \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} P_{1t-k} \\ P_{2t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

decomposed into $\boldsymbol{\pi}=\boldsymbol{\alpha}\boldsymbol{\beta}'$ and when r=1, $\boldsymbol{\alpha}=[\boldsymbol{\alpha}_1, \boldsymbol{\alpha}_2]'$ is the adjustment vector and $\boldsymbol{\beta}=[\boldsymbol{\beta}_1]$,**.....4**

$\boldsymbol{\beta}_2]'$ is the co-integrating vector. In this case, above-mentioned equation can be rewritten as equation 4: Harris (1995) narrated that there are three realistic models (denoted as Models 2-4) implicit in above equation. Model 2 is where there are no linear trends in the levels of the endogenous I (1) variables and the first-differenced series have zero means; here the intercept is restricted to the co-integration space. Model 3 is where there are linear trends in the levels of the endogenous I (1) variables and there is an intercept in the short-run model only. Model 4 is where the model does not account for any long-run linear growth and a linear trend is present in the co-integration vectors. To test between these models, the Pantula principle (Harris 1995) is used to test the joint hypothesis of both rank and the deterministic components (Johansen 1992).

Even if co-integration is established among the series, still there may be disequilibrium in the short run i.e. price adjustments across markets may not happen instantaneously. It may have some time for adjustment and time to remove these adjustments. Another important implication of co-integration and the error correction representation is that co-integration between two variables implies the existence of causality (in the Granger sense) between them in at least one direction (Granger 1988). Nevertheless, if two markets were integrated, the price in one market, p1, would commonly be found to Granger-cause the price in the other market, p2 and/or vice versa. Therefore, Granger causality provides additional evidence as to whether, and in which direction, price transmission is occurring between two series. If the series P_{it} and P_{ij} are I (1) and co-integrated, then the ECM model is represented by the following equations.

$$\Delta P_{it} = \alpha_0 + \sum_{t=1}^{n} \beta_i \Delta P_{(t-1)i} + \sum_{t=1}^{n} \beta_j \Delta P_{(t-1)j} + \delta ECT_{t-1} + \mu_t \quad \text{.....} \quad \textbf{(5)}$$

$$\Delta P_{jt} = \varphi_0 + \sum_{t=1}^{n} \sigma_j \Delta P_{(t-1)j} + \sum_{t=1}^{n} \sigma_i \Delta P_{(t-1)i} + \lambda ECT_{t-1} + \varepsilon_t \quad \text{.....} \textbf{(6)}$$

Where Δ is difference operator, P_{it} is the price series in Karachi market (i=1) and P_{ij} is the price series in other markets (i=2. . . . . 10) μ_t and ε_t are the white noise error terms, ECT_{t-1} is the error correction term (adjustment vector) derived from the long-run co-integrating relationship, while n is the optimal lag length orders of the variables which are determined by using the general-to-specific modeling procedure (Hendry and Ericsson 1991). The null hypotheses are: P_{it} will granger cause P_{ij} if $\mu_t \neq 0$. Similarly, P_{ij} will granger cause P_{it} if $\varepsilon_t \neq 0$. To implement the Granger-causality test, F-statistics are calculated under the null hypothesis that in above equations all the coefficients of μ_t and $\varepsilon_t = 0$.

DATA AND RESULTS

Monthly wholesale prices (RS /40kgs) of onion and potato were used in this study. The data were collected from the various issues of Agricultural Statistics of Pakistan. The study analyzed the price transmission in four selected regional markets of Pakistan. The markets included in this study are Lahore, Hyderabad, Peshawar and Quetta. Lahore is the base market. The criterion for selecting these markets is based on net market

positions (surplus and deficit), geographical distribution, data availability and the volume of trade or the importance of the market to the national onion and potato trade flow. Traditional time series econometric techniques were based on the assumption of stationary. However, a recent progress in time series econometric approaches shows that the most time series are non-stationary. If the time series is non-stationary, then usual statistical tools cannot be used to analyze data because these tools will give insignificant results. Most economic time series are trended over time and regression among trended series may provide results with high R2 s but may be of no use or spurious. Market integration can be taken as indicator of domestic market efficiency because in efficient domestic markets any change in the base market is fully transmitted to the other markets. In order to check the efficiency of domestic markets, integration level among major onion markets was estimated.

4.1 Unit Root Test

Augmented Dickey Fuller (ADF) unit root tests are used to determine whether each time series is stationary or not. The null hypothesis is that the variable observed has a unit root, against the alternative that it does not. Table 4.1 (appendices) depicts the results of test of the series (in logarithms) for unit roots using ADF Test (Dickey and Fuller 1979; Fuller 1976) both with and without linear trend. In non-trended Model, the absolute values of the ADF statistics for all four domestic onion markets (Lahore, Hyderabad, Peshawar, and Quetta) (1.62, 2.55, 2.44 and 2.66) are well below the 95 percent critical values of the test (2.88), and hence the null hypothesis that all the four variables have unit roots is firmly accepted. Thus we conclude that the data series of domestic onion markets are non-stationary. In Trended Model, the absolute values of the ADF statistics for domestic onion markets (3.34, 3.32, 2.78 and 2.95) are well below the 95 percent critical value of the test (3.44). Therefore, we concluded that in Trended Model, all series are non-stationary.

Table 4.2 indicates the first differenced test results. In both non- trended and Trended Models, the first difference absolute value of the T-statistics for all variable (11.59, 11.58, 10.03 and 10.88) are well above the above the 95 percent critical value of the test (2.88) to reject the null hypothesis. This means that all the variables have no unit roots in their first difference form. Therefore we conclude that they have become stationary after first difference. This show that these data series are I (1)

4.2 Co-integration Analysis

To evaluate the co-integration relationships, the Johansen trace Test and Maximum Eigen value test were applied.

i) Trace Test
ii) Maximum Eigen value Test

For the given onion markets in Pakistan, co-integration analysis is conducted. In first stage price linkages among all the domestic onion markets are checked then pair wise integration between Lahore (base market) and other selected markets is conducted.

4.2.1 Overall Integration among Onion Markets of Pakistan

As a first step in testing co-integration in onion markets of Pakistan, analysis was performed on overall basis for five major onion domestic markets viz. Lahore, Hyderabad, Peshawar and Quetta markets. The results of this analysis show that onion markets in Pakistan are well integrated with each other. According to trace test, first test statistics 79.53 is greater than 95% critical value 53.48 showing the presence of one

co-integrating vector. The second test statistics 50.45 is also greater than 95% critical value of 34.87, again showing the presence of another integrating vector. Subsequent observations of the results show the similar trend which shows on overall basis the three integrating vectors in the data series of major onion markets in Pakistan (see table 4.3 in appendix).

The results of maximal Eigen value test show that first test statistics 29.08 is greater than 95% critical value 28.27 showing the presence of one co-integrating vector. The second test statistics 26.19 is also greater than 95% critical value of 22.04, again showing the presence of another integrating vector. Subsequent observations of the results show the similar trend which shows on overall basis the three integrating vectors in the data series of major onion markets in Pakistan. As such, based upon the findings of both trace and maximal eigen value tests, it may safely be concluded that onion markets in Pakistan are well connected with each other and transmit price signals from each other (table 4.3). These findings are similar with the work of Mushtaq (2006), Ghafoor et al., (2009), and Mehmood (2010).

4.2.2 Pair Wise Integration between Onion Markets

Pair wise co integration in onion markets of Pakistan, analysis was performed for four major onion domestic markets viz. Lahore, Hyderabad, Peshawar and Quetta markets.

Lahore-Hyderabad Onion Markets

Results of trace test (see table 4.4) depicts that there is one co-integrating vector in the Lahore and Hyderabad onion markets on 95 percent critical value. One statistical value i.e. 28.61 which is greater than 95 percent critical value i.e. 20.18 which, shows that there exist one co-integrating vector whereas the second statistical value i.e. 4.79 is smaller than 95 percent critical value i.e. 9.16 which shows that there is no co-integration present.

The results of Maximal Eigen value Test show that there is one co-integrating vector in onion markets of Lahore and Hyderabad on 95 percent critical value. One statistical value i.e. 23.82 is greater than 95 percent critical value i.e. 15.87 which, shows that there exist one co-integrating vector whereas the second statistical value i.e. 4.79 is smaller than 95 percent critical value i.e. 9.16 which shows that there is no co-integration. It means Lahore as a base market transfer price signals to other Hyderabad market, the results are consistent with Mushtaq (2006), Ghafoor et al., (2009) and Mehmood (2010).

Lahore-Peshawar Onion Markets

Results of trace test (table 4.5) depicts that there is one co-integrating vector in the onion Lahore and Peshawar on 95 percent critical value. One statistical value i.e. 32.25 which is greater than 95 percent critical value i.e. 20.18 which, shows that there exist one co-integrating vector whereas the second statistical value i.e. 3.91 is smaller than 95 percent critical value i.e. 9.16 which shows that there is no co-integration is present.
The results of Maximal Eigen value Test show that there is one co-integrating vector in onion markets of Lahore and Peshawar on 95 percent critical value. One statistical value i.e. 28.33 is greater than 95 percent critical value i.e. 15.87 which, shows that there exist one co-integrating vector and whereas the second statistical value i.e. 3.91 is smaller than 95 percent critical value i.e. 9.16 which, shows that there is no co-integration is present.

Lahore-Quetta Onion Markets

Results of trace test (table 4.6) depicts that there is one co-integrating vector in onion Lahore and Quetta markets on 95 percent of critical value. One statistical value i.e. 82.87 which is greater than 95 percent critical value i.e. 27.16 which, shows that there exist one co-integrating vector whereas the second statistical value i.e. 4.99 is smaller than 95 percent critical value i.e. 3.04 which shows that there is no co-integration.
The results of Maximal Eigen value Test show that there is one co-integrating vector in onion markets of Lahore and Quetta on 95 percent critical value. One statistical value i.e. 22.17 is greater than 95 percent critical value i.e. 11.03 which shows that there exist one co-integrating vector whereas the second statistical value i.e. 0.46 is smaller than 95 percent critical value i.e. 3.04 which shows that there is no co-integration.

Hyderabad-Peshawar Onion Markets

Results of trace test (table 4.7) depicts that there is no co-integrating vector in the onion Hyderabad and Peshawar markets on 95 percent critical value. One statistical value i.e. 9.67 which is smaller than 95 percent critical value i.e. 12.36 which show that there exist no co-integrating vector whereas the second statistical value i.e. 0.92 is also smaller than 95 percent critical value i.e. 3.04 which shows that there is no co-integration.

The results of Maximal Eigen value Test show that there is one co-integrating vector in onion markets of Hyderabad and Peshawar on 95 percent critical value. One statistical value i.e. 9.45 is smaller than 95 Percent critical value i.e. 11.03which shows that there exist no co-integrating vector whereas the second statistical value i.e. 0.22 is smaller than 95 percent critical value i.e. 3.04 which shows that there is no co-integration.

Hyderabad-Quetta Onion Markets

Results of trace test (table 4.8) depicts that there is one co-integrating vector in the onion markets of Hyderabad and Quetta on 95 percent critical value. The presence of co-integration vector implies the long run interrelationship between the markets; the results are similar to (Gonz´alez-Rivera and Helfanad 2001). One statistical value i.e. 18.66 which is greater than 95 percent critical value i.e. 12.36 which shows that there exist one co-integrating vector whereas the second statistical value i.e. 0.16 is smaller than 95 percent critical value i.e. 4.16 which shows that there is no co-integration.

The results of Maximal Eigen value Test show that there is one co-integrating vector and one common trend in onion markets of Hyderabad and Quetta on 95 percent critical value. One statistical value i.e.18.49 is greater than 95 percent critical value i.e. 11.03 which shows that there exist one co-integrating vector whereas the second statistical value i.e. 0.16 is smaller than 95 percent critical value i.e. 4.16 which shows that there is no co-integration.

Peshawar-Quetta Onion Markets

Results of trace test (table 4.9) depicts that there is one co-integrating vector in the onion markets of Peshawar and Quetta on 95 percent critical value. One statistical value i.e. 16.95 which is greater than 95 percent critical value i.e. 12.36 which, shows that there exist one co-integrating vector whereas the second statistical value i.e. 0.23 is smaller than 95 percent critical value i.e. 4.16 which shows that there is no co-integration. The results of Maximal Eigen value Test show that there is one co-

integrating vector and one common trend in onion markets of Peshawar and Quetta on 95 percent critical value. One statistical value i.e. 16.72 is greater than 95 percent critical value i.e. 11.03 which shows that there exist one co-integrating vector whereas the second statistical value i.e. 0.23 is smaller than 95 percent critical value i.e. 4.16 which shows that there is no co-integration.

4.2 Adjusted Vector from ECM for Onion Markets

When we express market integration through co-integration there could be disequilibrium in the short-run, i.e. price adjustment across markets may not happen instantaneously. It may take some time for spatial price adjustments to happen. The error correction model takes into account the adjustment of short-run and long-run disequilibrium in markets and time to remove disequilibria in each period. Table-4.11 shows that 5-285% disequilibrium is removed in each period, i.e. one month in the onion market of Pakistan.

The value of co-efficient demonstrates that 21 percent equilibrium is adjusted between Lahore and Hyderabad markets after one month. While only just 5percent disequilibrium is removed between Lahore and Peshawar markets after one month and 133percent disequilibrium is removed between Lahore and Quetta markets after a period of one month. In Hyderabad and Peshawar markets 88 percent equilibrium is adjusted after one month. In Hyderabad and Quetta markets 285 percent disequilibrium is removed after one month. While in Quetta and Peshawar markets 92 percent equilibrium is adjusted after one month. On average onion markets will take 3-4 months to move towards equilibrium.

4.3 Granger-Causality for Onion Markets

Granger causality is also estimated between pairs of these onion markets. Granger causality means the direction of price formation between two markets and related spatial arbitrage i.e. physical movements of commodity to adjust for these price differences. Granger (1969) introduced a concept of causality, a variable X is said to be Granger caused by another variable Y if current values of X can be predicted with better accuracy by using past values of Y (Yuan and Kochhar 1994; Takamastu 2002).

In this analysis, granger causality was estimated between onion market pairs. The results of domestic markets showed that one market pair was related in bidirectional way whereas three market pairs were related with each other in a unidirectional manner.

The base market Lahore showed bidirectional causality with Hyderabad. This implies that Lahore market granger causes price formation in this market and vice versa. This implies that these markets are strongly related with each other experiencing physical arbitrage to settle any disequilibrium between the markets. Further, unidirectional causality was found between Lahore and Peshawar and Lahore and Quetta. This implies that Lahore granger causes price formation in Peshawar and Quetta but not vice versa.

As far as causality between Hyderabad and Peshawar onion market was concerned, Hyderabad market shows unidirectional causality with Peshawar market. That means Hyderabad market granger causes price formation in Peshawar market but not vice versa. The relation between Hyderabad and Quetta onion prices is found unidirectional implying that Hyderabad market granger causes price formation in Quetta market but

not vice versa. Further, unidirectional causality was also found between Quetta and Peshawar. This implies that Quetta causes price formation in Peshawar onion market but not vice versa. So concluding it may be said that price transmission of onion in the domestic level these markets are well integrated.

CONCLUDING REMARKS

Average monthly wholesale prices (January 2000-December 2009) of four onion markets Lahore, Hyderabad, Peshawar and Quetta were used for analysis. The findings of the study revealed that selected four major onion markets were integrated with each other. The results of Error Correction Model for pair of onion markets showed that 5 to 285 percent of the disequilibrium was removed each time period i.e. one month. This implies that following shocks to the selected markets which cause disequilibrium, economic agents take 3 to 4 months to adjust the disequilibrium and move back to long run equilibrium. These findings were supported with the results of granger causality analysis which confirmed the presence of co-integrating relationship among the variables. The study confirmed that market price linkages and the interrelationship among spatial markets are important in economic analysis. The high degree of market integration observed in this case is consistent with view that onion markets in Pakistan are linked with each other for price transmission and related physical arbitrage. As such, it is concluded that policies designed to govern working of onion markets in Pakistan are good enough to ensure efficiency as such leave little justification for government interventions.

References

Books

Greene, W. H., 2000. *Econometric Analysis*. New Jersey: Prentice-Hall, Inc.

Harris, R., 1995. *Using Cointegration Analysis in Econometric Modelling*. London: Prentice Hall-Harvester Wheatsheaf.

Journals and Publications

Dad, M., 2007. *Apple Market Integration in Pakistan*. MS.c (Hons.) Thesis, Department of Agricultural Economics, University of Agriculture Faisalabad.

Dickey, D. A. and W. A. Fuller, 1981. "Likelihood ratio statistics for autoregressive time series with a unit root", in *Econometrica, 49, 1057-1072*.

Engle, R. F. and Granger, C.W.J., 1987. "Cointegration and error correction: representation, estimation and testing", in *Econometrica, 55:251-276*.

Ghafoor, A., K. Mustafa, K. Mushtaq, and Abedullah, 2009. "Co-integration and Causality: An Application to Major Mango Markets in Pakistan", in *The Lahore Journal of Economics, 14(1): 85-113*.

Gonz´alez-Rivera, G. and S. M. Helfand, 2001. "The Extent, Pattern, and Degree of Market Integration: A Multivariate Approach for the Brazilian Rice Market", in *American Journal of Economics, 83(3): 576–592.*

Government of Pakistan (GOP), 2010. *Agricultural Statistics of Pakistan 2009-10*. Islamabad: Ministry of Food Agriculture and Livestock (Economic Wing).

Government of Pakistan, 2011. *Pakistan Economic Survey 2010-11*. Islamabad: Finance Division, Economic Advisor's Wing.

Granger, C. W. J., 1981. "Some properties of time series data and their use in econometric model specification", in *Journal of Econometrics, 16:121-130.*

Granger, C. W. J., 1988. "Some recent developments in the concept of causality", in *Journal of Econometrics, 39:199-211.*

Johansen, S., 1988. "Statistical analysis of co-integration vectors", in *Journal of Economic Dynamics and Control, 12:31-254.*

Johansen, S., 1992. "Determination of Co-integration Rank in the Presence of a Linear Trend", in *Oxford Bulletin of Economics and Statistics, 54, 383-97.*

Johansen, S., 1995. "Likelihood-based inference in co-integrated vector-autoregressions", in *Advanced Texts in Econometrics.* Oxford: Oxford University Press.

Johansen, S., 1991. "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", in *Econometrica, 59:551-1580.*

Lohano, H. D. and F. M. Mari, 2005. "Spatial Price Linkages in Regional Onion Markets of Pakistan", in *Journal of Agriculture and Social Sciences, 01 (4), 66-79.*

Mari, F. M., 2009. "Structure and Efficiency Analysis of Vegetable Production and Marketing in Sindh, Pakistan". Tando Jam: Department of Agricultural Economics, Faculty of Agricultural Social Sciences Sindh Agriculture University.

Mehmood, A., 2010. *Are Punjab Rice Farmers Benefited from Agricultural Trade Reforms: Analysis via Price Transmission in Selected Rice Markets in Punjab, Pakistan?* MSc Thesis. Department of Agri. Economics, Faculty of Agri. Economics and Rural Sociology, University of Agriculture, Faisalabad.

Mushtaq, K. F. Abbas, A. Ghafoor, 2006. "Testing the law of one price' rice market Integration in Punjab, Pakistan", in *Pakistan Journal of Agricultural Sciences, 43 (3-4).*

Tahir, Z. and K. Riaz, 1997. "Integration of Agricultural commodity Market in Punjab", in *The Pakistan Development Review*, 36(3): 241-262.

Takamastu, S., 2002. *Economic Analysis of Rice Market Integration in Loas.* A summary of Master Thesis Presented to the Graduate School of International Cooperation Studies, Kobe University.

Yuan, M. and K. Kochhar, 1994. "An Empirical Analysis Using Johansen's Cointegration Approach", in *Central Asia Department China's Import IMF Working Paper WP/94/145*. International Monetary Fund.

Zahid, S., A. Qayyum and W. Shahid, 2007. "Dynamics of Wheat Market Integration in Northern Punjab, Pakistan", in *The Pakistan Development Review, 46 (4): 817-830*.

Online Article

Hussain, B., 2010. "Testing the Law of One Price in Gram Markets of Pakistan", in *MPRA Paper No. 30708*. [online]. [accessed May 2011 / 02:12].

Appendixes

Table 4.1
Unit Root Test Results (Onion Markets)

Variables	Non-Trended Model	Trended Model	Results
Lahore	1.62	3.34	I(1)
Hyderabad	2.55	3.32	I(1)
Peshawar	2.44	2.78	I(1)
Quetta	2.46	2.95	I(1)
Critical Values	-2.88	-3.44	

Note: CV are at 95 percent confidence interval from Fuller (1976, pp.373)

Table 4.2
First Difference ADF Unit Root Test Results (Onion Markets)

Variables	Non-Trended Model	Trended Model
Lahore	11.59	11.54
Hyderabad	11.58	11.53
Peshawar	10.03	9.99
Quetta	10.88	10.83
Critical Values	-2.88	-3.44

Note: CV are at 95 percent confidence interval from Fuller (1976, pp.373)

Table 4. 3
Overall Integration among Onion Markets of Pakistan

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore, Hyderabad, Peshawar and Quetta markets	r = 0 r ≤ 1 r ≤ 2 r ≤ 3	r ≥ 1 r ≥ 2 r ≥ 3 r ≥ 4	79.53 50.45 24.25 4.56	53.48 34.87 20.91 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore, Hyderabad, Peshawar and Quetta markets	r = 0 r ≤ 1 r ≤ 2 r ≤ 3	r ≥ 1 r ≥ 2 r ≥ 3 r ≥ 4	29.08 26.19 19.68 4.56	28.27 22.04 15.87 9.16

Table 4.4
Test for Lahore and Hyderabad Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Hyderabad	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	28.61 4.79	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Hyderabad	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	23.82 4.79	15.87 9.16

Table 4.5
Test for Lahore and Peshawar Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Peshawar	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	32.25 3.91	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Peshawar	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	28.33 3.91	15.87 9.16

Table 4.6
Test for Lahore and Quetta Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	27.16 4.99	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Lahore-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	22.17 4.99	15.87 9.16

Table 4.7
Test for Hyderabad and Peshawar Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Hyderabad-Peshawar	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	29.41 4.97	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Hyderabad-Peshawar	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	24.43 4.97	15.87 9.16

Table 4.8
Test for Hyderabad and Quetta Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Hyderabad-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	30.27 5.58	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Hyderabad-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	24.69 5.58	15.87 9.16

Table 4.9: Test for Peshawar and Quetta Onion Markets

Trace Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Peshawar-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	27.68 5.97	20.18 9.16
Maximal Eigen value Test				
Markets	**Null**	**Alternative**	**Statistics**	**95% CV**
Peshawar-Quetta	r = 0 r ≤ 1	r ≥ 1 r ≥ 2	21.71 5.97	15.87 9.16

Table 4.10: Adjusted Vector from ECM for Onion Markets

Market Pairs	Co-efficient	T-Value	P-Value
Lahore-Hyderabad	-0.21	-3.33	0.00
Lahore-Peshawar	-0.05	-2.75	0.00
Lahore-Quetta	-1.33	-3.68	0.00
Hyderabad-Peshawar	-0.88	-1.97	0.05
Hyderabad- Quetta	-2.85	-7.40	0.00
Quetta-Peshawar	-0.92	-2.18	0.03

Table 4.11: Granger-Causality Results for Onion Markets

Causality	F-statistics	P-Value	Results
Lahore-Hyderabad	8.30	0.00	Bidirectional
Hyderabad-Lahore	3.96	0.01	
Lahore-Peshawar	9.54	0.00	Unidirectional
Peshawar-Lahore	1.24	0.29	
Lahore-Quetta	8.27	0.00	Unidirectional
Quetta-Lahore	1.35	0.26	
Hyderabad-Peshawar	2.95	0.03	Unidirectional
Peshawar- Hyderabad	5.37	0.70	
Hyderabad- Quetta	2.26	0.08	Unidirectional
Quetta Hyderabad	1.03	0.37	
Quetta-Peshawar	2.33	0.07	Bidirectional
Peshawar-Quetta	2.27	0.00	